

Remote sensing in armed conflict studies: a bibliometric analysis

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ABSTRACT

This article addresses the potential use of remote sensing in conducting studies related to armed conflict. To carry out this approach, a bibliometric analysis was carried out, applying the preferred reporting items for systematic reviews and meta-analyses (PRISMA) methodology, through which we sought to identify the most relevant authors, the geographical distribution of productivity, and the research trends in the area. The analysis was carried out with information obtained from the Scopus reference database in August 2024. The results indicate that productivity growth began in the 2000s and is still under development. Additionally, the review of the articles indicated that the use of remote sensing in relation to armed conflicts has focused mainly on the study of the effects of armed conflict on land cover, environmental stability and, more recently, on the impact on agricultural areas from a food security perspective.

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1. INTRODUCTION

Armed conflict is a phenomenon that leaves significant impacts on territories and differentially affects the social, economic, and environmental aspects of populations. Identifying and understanding these transformations requires methodologies that can go beyond traditional field methods and statistical records, which are often difficult to obtain in challenging security contexts like the ones considered here.

Given this reality, remote sensing emerges as a useful alternative for studying the dynamics of armed conflict. These dynamics result in the victimization of both the population and the environment through actions such as murder, land dispossession, displacement, terrorist attacks, and the emergence of irregular exploitation of natural resources to sustain armed groups [1]-[4].

Several studies have explored the advantages of remote sensing in understanding the consequences of armed conflict. For example, some studies have focused on establishing changes in vegetation cover and protected areas due to armed conflict actions [5]-[7]. Other works, such as [8], use nighttime imagery to examine its relationship with the presence of armed conflicts in different parts of the world. Specifically, some studies seek to establish the impact of war on agricultural zones [9], [10]. These works demonstrate that remote sensing is emerging as an important tool for understanding the effects of armed conflict globally.

However, some gaps have been identified in the existing literature, particularly because these studies pay special attention to deforestation associated with armed conflict or to the direct presence of war itself. For example, there has been little study on the impacts on water bodies or the relationship with social variables that would allow for establishing the economic impacts on rural populations. Similarly, the impact on structures has been poorly studied using these methodologies.

Considering the above, this work proposes a bibliometric review of the relationship between remote sensing and armed conflict studies. Through a quantitative analysis of studies found on the Scopus platform, it presents the main authors in the field, the countries where these types of studies are developed, and the thematic areas that emerge from this pairing. From this review, we seek to contribute to the understanding of remote sensing's application to armed conflict studies, highlighting the emerging topics and how it is becoming a valuable field for current and future work on the subject. This document first presents the methodological process developed for the bibliographic review. It then outlines the findings related to the main research lines, authors, and thematic areas. Finally, it concludes with the principal findings, research areas with potential for development, and the contributions of remote sensing to this end.

2. METHOD

This article is based on the method of bibliometric analysis, a research technique that seeks, through mathematical and statistical reviews, to characterize the scientific production in a given area of study [11]. The analysis of the contribution of remote sensing to armed conflict studies was framed in a period from 1991 to the year 2024 and was carried out seeking to answer questions such as: who has done research on the topic, Where, and What other topics are related?

The search for papers was carried out in the Scopus reference base in August 2024. Scopus is one of the largest curated databases with access to more than 1.7 billion references, making it a platform for gathering significant amounts of information for bibliometric analysis [12]. The search equation used was: “remote AND sensing AND armed AND conflict”. A total of 111 articles were initially obtained. However, following a detailed individual review and the application of the exclusion criteria, which are outlined below, 61 articles were included in the review. The remaining articles were excluded as they were not directly associated with the scope of this study. Bibliometrics was developed by applying the preferred reporting items for systematic reviews and meta-analyses (PRISMA) methodology [13], which allows defining a reliable workflow for the selection and evaluation of articles in the area (Figure 1).

The exclusion criteria were:

- Armed conflict is not a central issue
- The use of remote sensing is not related to the study of armed conflict
- The study of armed conflict does not consider remote sensing as a form of study

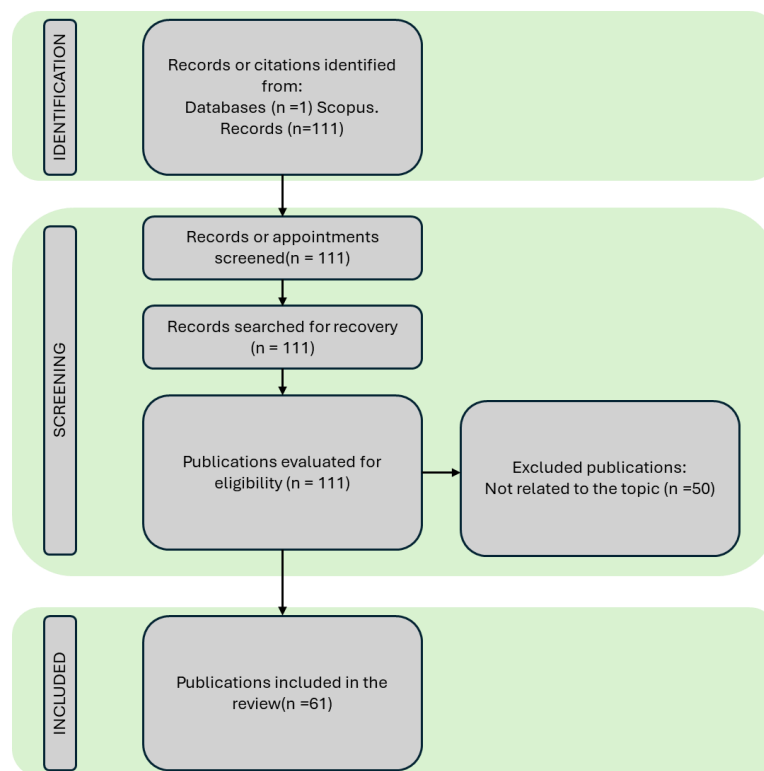


Figure 1. PRISMA flowchart

For the bibliometric analysis, the tools VOSviewer [14] and the Bibliometrix library in R software [15] were used to process the data obtained from the Scopus platform after the data curation process. In this analysis, four categories were considered to review the general trends in the field: i) publication trends over time, ii) authorship, iii) publication venues, and iv) citation impact. Additionally, an analysis of relationships was performed through co-occurrence and co-citation analysis.

3. RESULTS AND DISCUSSION

In this section, it is explained the results of research and at the same time is given the comprehensive discussion. Results can be presented in figures, graphs, tables and others that make the reader understand easily [16], [17]. The discussion can be made in several sub-sections.

3.1. Temporal evolution overview

Figure 2 shows the temporal behavior of publications related to the subject of analysis. From 2008 onwards, it was possible to observe a growing trend in scientific productivity; up to 2007, accumulated productivity represented 7% of the total of 60 articles; in 2008, such productivity was 12% of the total, i.e. 5% more than the previous year. In the year 2023, 90% of the total productivity was reached, and the publications made in that year (12) represent a contribution of 20% to the total productivity. In addition, for the year 2024, up to the date of the search performed, 6 articles were obtained, that is, 10% of the total productivity.

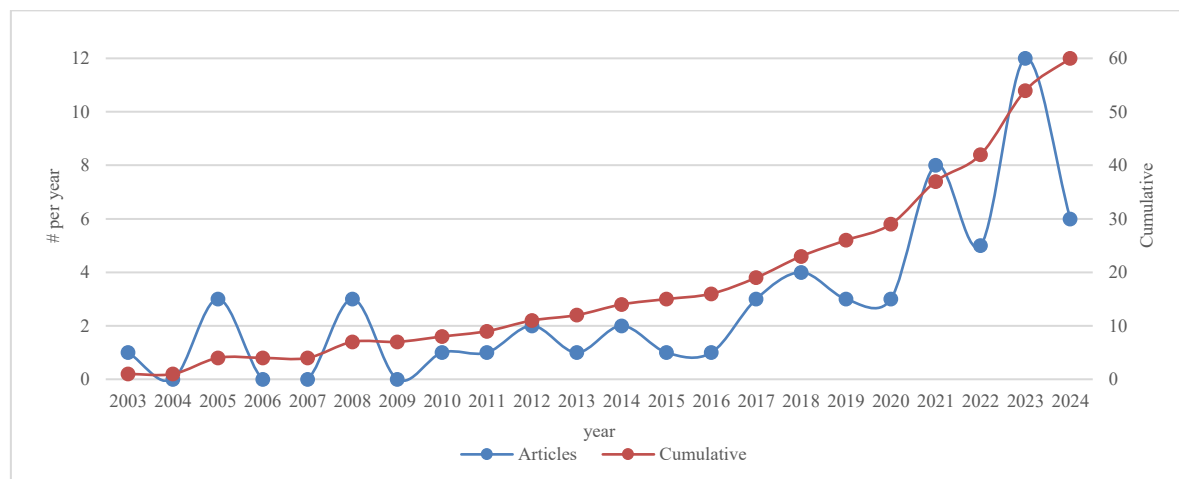


Figure 2. Temporal evolution of productivity

The analysis of the temporal evolution of publications on this topic reveals a sustained growth in the use of remote sensing in armed conflict studies. Although publications were scarce in the early 2000s, there has been a significant increase in the last four years. This trend leads to two important conclusions: first, the utility and relevance of remote sensing in social science studies, and second, the growing interest in understanding the effects of armed conflicts on territories.

3.2. Journals and autor productivity

A total of 48 sources were found, mainly associated with topics in remote sensing, environment, geography, and earth studies. Table 1 presents the 10 most relevant sources with the highest productivity. Four sources specialized in remote sensing were identified, with the remainder related to environmental, conservation, and resource monitoring topics.

The journals with the highest number of publications are: remote sensing, science of remote sensing, and science of the total environment, each with 3 publications that represent 3% of the total articles. All are classified as Q1 journals. In terms of scope, the first two journals focus on publishing articles that cover the theory and application of remote sensing and novel remote sensing techniques for studying earth sciences, land cover and land use, oceanography, agriculture, among other areas. The third journal focuses on environmental research, considering, among other techniques, the application of remote sensing to contribute to the understanding of natural processes and their effects.

Furthermore, Table 2 shows the 10 most relevant authors on the topic, a measurement based on the number of articles in which the researcher has a co-authorship. These authors have had their productivity between the year 2008 and the year 2022. Table 2 reveals that the most productive author is Prishchepov Alexander V with 3 articles; authors with recent productivity include Huang Qiongyu with his last article published in 2023, and Prishchepov Alexander V, Baumann Matthias, and Kuemmerle Tobias, with their last publication in 2022. Germany has the highest representation among the most productive authors with a total of 3 authors, followed by the USA and Ivory Coast, both with 2 authors. Regarding institutions, the one with the highest representation is Humboldt University of Berlin in Germany, with 2 authors.

Table 1. Main sources of publications

Source name	Articles	%	Scimago journal rank
Remote Sensing	3	3	Q1
Science of Remote Sensing	3	3	Q1
Science of the Total Environment	3	3	Q1
Biodiversity and Conservation	2	2	Q1
Global Ecology and Conservation	2	2	Q1
Global Environmental Change	2	2	Q1
International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences - ISPRS archives	2	2	Q3
International Conference of Young Professionals "geoterrace 2023"	2	2	Conference proceedings
Land	2	2	Q1
Remote Sensing of Environment	2	2	Q1
Other journals	88	79	

Table 2. Most relevant authors

Authors	Articles	Institution	Country	Date first publication	Date last publication
Prishchepov Alexander V	3	University of Copenhagen	Denmark	2019	2022
Andrieu Julien	2	Institut Français de Pondichéry	France	2016	2018
Barima Yao Sadaïou Sabas	2	Public university in Daloa	Ivory Coast	2016	2018
Baumann Matthias	2	Humboldt University of Berlin	Germany	2019	2022
Butsic Van	2	University of California	USA	2019	2021
Huang Qiongyu	2	Smithsonian Conservation Biology Institute	USA	2021	2023
Jongerden Joost Hugo de Vos	2	Free University Amsterdam	Netherlands	2008	2008
Kouakou Akoua Tamia Madeleine	2	Public university in Daloa	Ivory Coast	2016	2018
Kranz Olaf	2	German Aerospace Center (DLR)	Germany	2010	2017
Kuemmerle Tobias	2	Humboldt University of Berlin	Germany	2019	2022

Article production on this topic is significant across a substantial number of journals, with a notable presence in high-impact publications within fields such as remote sensing, geography, earth sciences, and the environment. This highlights the interdisciplinary approach used to study armed conflict and measure its impacts. Regarding authors, the most relevant researchers in the field have relatively recent publications, which corresponds with the years of increased production. The work developed by these authors has been applied at local, regional, and national scales, with many of them using multitemporal analysis with satellite imagery as the core methodology for their studies.

3.3. Co-citation of authors and collaboration between countries

The co-citation analysis considered at least 15 citations as a threshold, obtaining 16 authors grouped in 4 clusters (Figure 3). The first cluster (blue) addresses the effects of the armed conflict on cultivated areas through remote sensing and is in turn related to the second cluster (red), which also studies the impact of this phenomenon on forests. The third cluster (green) focuses on impacts to forest areas while the fourth cluster (yellow) relates these impacts to the activities of the population due to phenomena such as displacement and refugee camps.

Figure 4 presents the collaboration between countries, highlighting those with active armed conflicts such as Colombia [18], Sudan [19], and Ukraine [20]. Other countries like the USA, Germany, Italy, and China, which have significant technological capacity in remote sensing, are not currently facing armed conflicts themselves. However, they study the dynamics in conflict-ridden regions of the world due to economic, cooperation, and investment interests that may be affected by the crises in these countries [10], [21], [22]. In addition, there is a notable research collaboration between these technologically advanced countries and countries in South America and Africa, which are generally where the conflicts are concentrated.

According to Avtar *et al.* [23], the United States is a pioneer in the use of remote sensing for military and security purposes abroad. U.S. interest ranges from strategic military surveillance during the Cold War over adversaries such as the USSR and China to current use by U.S. nongovernmental organizations to monitor conflicts. On the other hand, [24], some of these countries, in addition to the strategic military applications of remote sensing in armed conflicts, have shown interest in academic and humanitarian studies on the environmental impacts of conflicts.

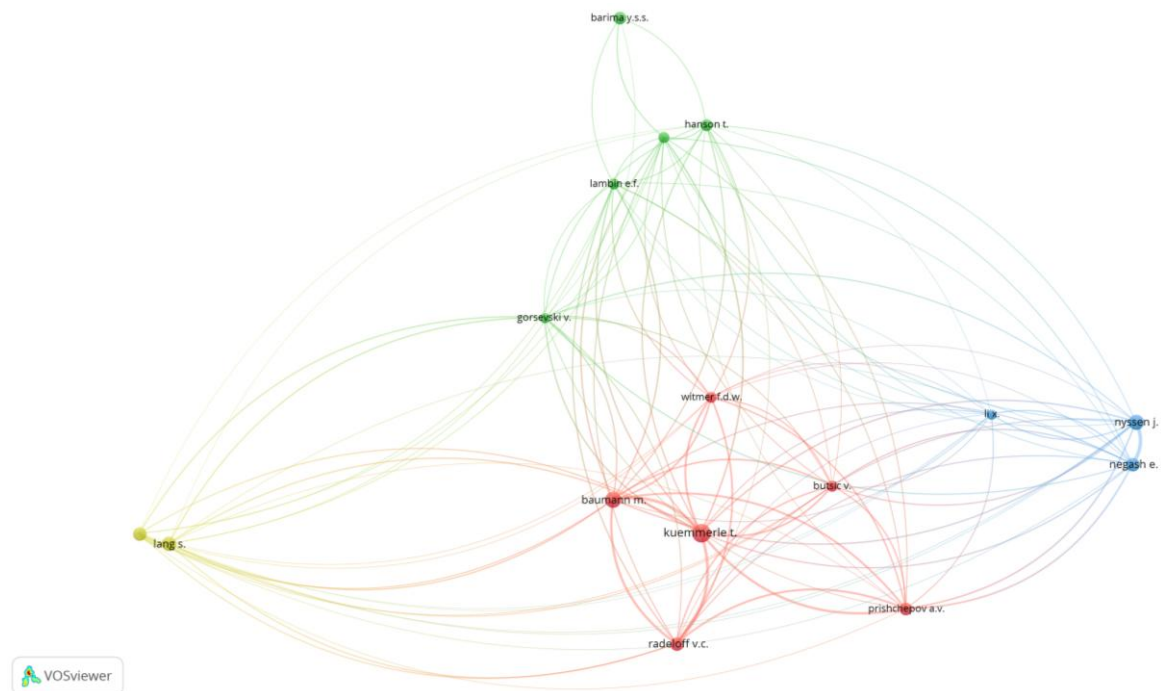


Figure 3. Author co-citation network

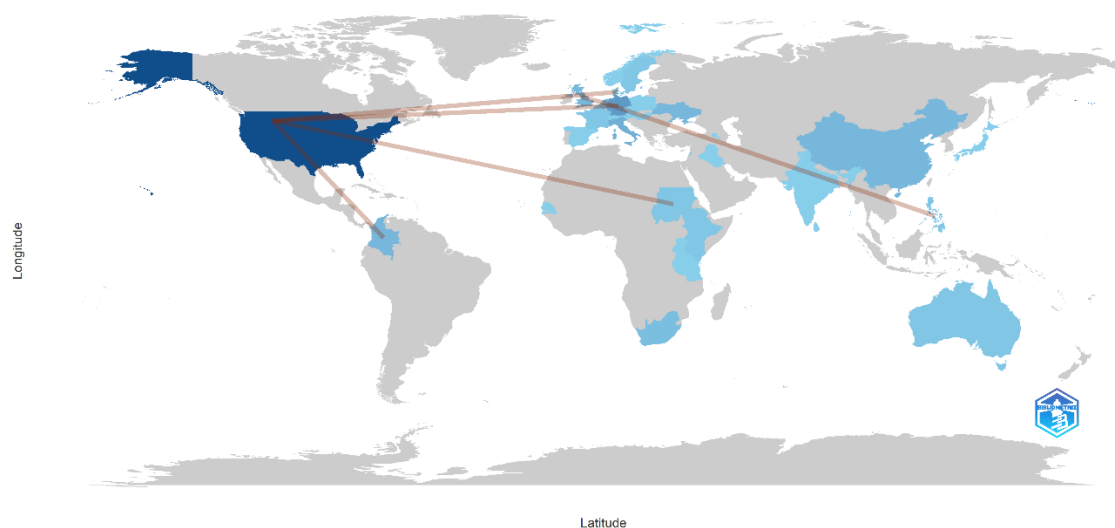


Figure 4. Collaboration between countries

3.4. Keyword co-occurrence

Finally, in an analysis of co-occurrence of keywords, of the 570 words in the database, 45 are present in at least 3 texts. After reviewing the terms that emerge in the analyzed works (Figure 5), several key areas are highlighted. These include change detection, deforestation, biodiversity, agriculture, environmental

protection, and emerging applications like machine learning. This confirms that land cover and areas of environmental importance are central themes when it comes to measuring the impacts of conflicts. However, this review also allows us to identify research needs in other topics that are not frequently mentioned, such as the effects on soil degradation, the impact on infrastructure, and water bodies. This shows that while remote sensing has been significantly integrated into understanding armed conflicts in recent years, there are still fields where it can contribute to a more comprehensive approximation of the impacts left on territories.

Regarding the temporal evolution of the topics, Figure 5 shows that in the early years the work focused on studying the consequences of the armed conflict on natural ecosystems, as a driver of deforestation and environmental degradation. Subsequently, topics such as the identification of changes in land cover and land use were added and, more recently, the impacts on agriculture and food security were studied.

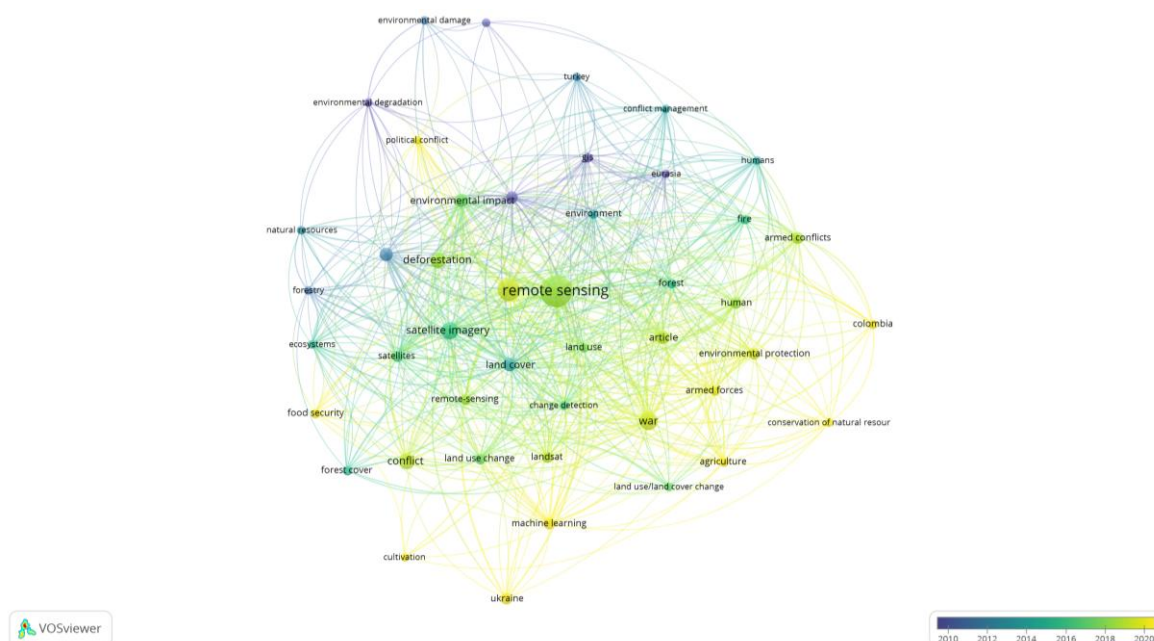


Figure 5. Keyword co-occurrence network

3.5. Most relevant articles

In this section, a review of the citation density of the publications was carried out. For this analysis, a minimum threshold of 10 citations was defined, and 23 documents were found that meet the threshold. The articles that stand out are those associated with the study of the environmental, economic, and land use consequences that arise from armed conflict [6], [8], [10]. Table 3 summarizes the 10 most cited articles, which show a combination of classical remote sensing methodologies with the use of novel techniques to approach the impacts of armed conflict.

These works stand out as a benchmark in the studied field, proposing the use of methodologies that adapt to the needs and possibilities of each case study. They combine satellite imagery with the generation of indices and indicators. The emphasis of these publications is on natural areas, blending variables derived from remote sensing with social and environmental measurements to seek explanations for the situations observed. Additionally, some works explore new approaches like food security and new methods such as combining with big data for the study of armed conflict.

Moreover, the presented works contribute to the generation of methodologies that enable the evaluation of environmental impacts caused by armed conflicts, including the effects on fauna and flora during periods of active conflict and in the post-conflict phase. This allows for identifying conservation needs and enables relevant organizations to project actions. Likewise, the integration of inputs such as nighttime imagery, big data, and object-oriented classification expands the possibilities for understanding the consequences of conflict at detailed and real-time scales.

Table 3. Most relevant articles

Ref.	Main topic	Inputs	Methodology	Main findings
[4]	Impact of Conflicts on Spatial and Temporal Forest Changes in West-Central Côte d'Ivoire	Landsat 5 images. Floristic and Dendrometric Inventories.	Supervised maximum likelihood classification; transition matrices; multitemporal analysis; Sørensen similarity index.	The impacts of conflicts in Côte d'Ivoire resulted in the regression of forest cover, fragmentation, and loss of biological diversity.
[7]	Impact of armed conflict on protected areas in Colombia	Moderate-resolution images (MODIS); Deforestation data; Geographic location and control by the FARC-EP guerrilla group.	The data were analyzed using a Poisson model with the fire count as the response variable.	The results showed that fires in protected areas have increased sixfold since the demobilization process and the probability of deforestation has increased by 52%.
[25]	Identification of World Heritage sites at risk from armed conflict	VIIRS nighttime lights images with 742 m spatial resolution; Forest fire data detected by MODIS; Global data on conflict events; Human Footprint Index.	Data were studied using Spearman's rank correlations for two periods, 2007–2010 and 2010–2018.	Nighttime lights are valuable for the identification of heritage sites at risk from conflict in near real-time.
[26]	Change detection as a consequence of conflict actions in Palestine and Macedonia	Ikonos images (2 m resolution and 1 m resolution).	They compared traditional techniques with an object-oriented image classification software.	Object-oriented image classification improves the identification of structural changes in very high-resolution images compared to traditional classification methods.
[27]	Forest transition in conflict and post-conflict in Rwanda	Landsat Thematic Mapper (TM) and Enhanced Thematic Mapper (ETM+) from July 1986, January 2003, August 2009, and July 2011.	Multitemporal analysis of Landsat data; Iteratively Reweighted Multivariate Alteration Detection (IR-MAD) method for radiometric normalization.	The impacts of conflicts on Rwanda's forests appear to be influenced by the use of natural resources near settlements.
[10]	Transformation of agricultural lands due to armed conflict in the Caucasus	Landsat satellite images; Conflict statistics between 1989 and 2011.	Logistic regression analysis to evaluate the role of conflict distance and intensity in land use changes in agricultural lands.	The findings indicate that lands closer to conflict zones have a higher probability of being abandoned, and once the conflict ends, only some areas return to agricultural uses, from which it is deduced that the impacts of armed conflict on land use patterns are lasting.
[28]	Changes in forest cover in Nicaragua	Landsat images.	Unsupervised land cover classification for the years 1978, 1988, and 1993; Change analysis; Origin matrix to study forest cover trends.	The results confirmed that in the first 5 to 7 years of the conflict, reforestation was greater than deforestation, but in the final years of the conflict, deforested land almost doubled that which was reforested.
[8]	Evaluation of the usefulness of nighttime lights in armed conflict studies	Nighttime light images acquired with the Defense Meteorological Satellite Program's Operational Linescan System (DMSP-OLS).	Annual composites of the nighttime light images were created; Nighttime Light Variation Index (NLVI) to quantify the variation of nighttime light from the time series; The probability of a country suffering armed conflicts was calculated using conditional probability analysis.	It was found that the outbreak of a war can reduce light and a ceasefire can increase it, which indicates that armed conflict events always have a significant impact on nighttime light.
[6]	Evaluation of the impact of war and postwar on forest ecosystems in the South Sudan-Uganda border region	Landsat images with 30 m resolution for the years 1986–1987, 2001, 2003, and 2010.	Disturbance Index (DI) to investigate the location and extent of forest cover loss and gain in three areas.	The results indicate that the forest recovery rate was significantly greater than the disturbance rate, both during and after the war, and the net rate of forest cover change remained virtually unchanged during both periods.
[29]	Evaluation of changes near displaced settlements in Sudan	QuickBird high-resolution images for the years 2002, 2004, and 2008.	Weighted natural resource depletion index that integrates expert-given weightings.	The results link the depletion of natural resources to the increase in displaced persons and indicate the environmental degradation that can occur due to conflicts.

Even so, approaching the impacts of armed conflict using remote sensing still presents some challenges that, depending on the study areas and available resources, can limit the results obtained. An

example of this is the spatial resolution of images; using open-access images like Landsat or Sentinel reduces the possibility of observing detailed changes in land cover [4]. Another limitation in studies of armed conflict and its consequences is the existence of data that allows for documenting and analyzing the before, during, and after periods of war [27], particularly regarding data on fauna and flora, and in some cases, the conflict events themselves.

What the presented works show is how remote sensing has been integrated into studies on armed conflict and its consequences, which addresses the objective set forth in this review. These studies demonstrate that remote sensing constitutes a valuable tool for monitoring impacts on environmentally, economically, and culturally important areas, and how its potential is enhanced by the combination with statistical data.

4. CONCLUSION

Bibliometric analysis is a useful methodology for recognizing the state of progress in a field and for identifying emerging topics and research trends, all of which are valuable when beginning a new study. This review showed that remote sensing constitutes a useful field for understanding the impacts of armed conflict, with its use primarily focused on evaluating environmental and land cover effects. More recently, studies have appeared that seek to evaluate the impacts on agricultural areas from a food security perspective.

This article presented a review of the literature found in Scopus that links remote sensing and armed conflict studies. Among the aspects to highlight is the still recent development of this field; its growth began in the 2000s, with notable authors emerging since 2008 and a growth trend in the number of publications since 2015. Despite this, the collaboration among countries is still confined to a few, such as the United States, Germany, and Colombia, and several of the most prominent countries in terms of publication numbers have active armed conflicts.

Additionally, the review of the field shows that while there have been significant advancements, there are still gaps in armed conflict studies that present opportunities for integrating new topics and methodologies. An example of this is the limited exploration of the impact on water bodies and productive infrastructure in rural areas, associated with wartime actions, as well as the processes of population displacement. Another aspect that did not appear in the review and could be addressed using remote sensing is the localization of victims or the quantification of economic losses caused by armed conflicts.

The methodological approach of these studies has favored the use of optical images. Some works have explored the possibilities offered by nighttime illumination imagery, as well as the combination of optical images with social data and big data for the generation of statistical analyses to measure the effects in the proposed study areas. This highlights the limitation of these studies to optical images and how the incorporation of other types of sensors like LiDAR or radar is still to be explored in this type of work.

The findings of this work allow us to see the possibilities for expanding the uses of remote sensing in armed conflict studies, to integrate the review of impacts in aspects that have been little explored so far, and to integrate complementary inputs and methodologies. Additionally, the integration of social aspects is an alternative that can broaden the understanding of the spatial effects of conflict dynamics in a territory. It is expected that these findings will serve as a basis for the generation of future research in the field and promote the integration of new holistic approaches to the visible impacts on the territory.

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C : Conceptualization

M : Methodology

So : Software

Va : Validation

Fo : Formal analysis

I : Investigation

R : Resources

D : Data Curation

O : Writing - Original Draft

E : Writing - Review & Editing

Vi : Visualization

Su : Supervision

P : Project administration

Fu : Funding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

DATA AVAILABILITY

Data availability is not applicable to this paper as no new data were created or analyzed in this study.

REFERENCES

- [1] M. R. Herrera, "Towards a definition of non-international armed conflict: from Geneva law to the Rome Statute of the ICRC," in *Preliminary approaches, reflections and criticisms on international humanitarian law*, 1st ed., Bogotá: Universidad Externado de Colombia, 2022.
- [2] M. Guanumen, "Dinámicas de la guerra, desafíos para la paz. La experiencia de Colombia," vol. 8, no. 1, pp. 40–61, 2015, doi: 10.14483/udistrital.jour.cpaz.2015.1.a03.
- [3] Jurisdicción Especial para la Paz, "El ambiente como víctima silenciosa," Bogotá, 2022. [Online]. Available: <https://www.eltiempo.com/colombia/calidano-ambiental-por-ataque-del-el-n-oleoducto-trasandino-en-narino->.
- [4] Y. S. S. Barima *et al.*, "Cocoa crops are destroying the forest reserves of the classified forest of Haut-Sassandra (Ivory Coast)," *Glob Ecol Conserv*, vol. 8, pp. 85–98, Oct. 2016, doi: 10.1016/j.gecco.2016.08.009.
- [5] R. Christiansen, M. Baumann, T. Kuemmerle, M. D. Mahecha, and J. Peters, "Toward Causal Inference for Spatio-Temporal Data: Conflict and Forest Loss in Colombia," *Journal of the American Statistical Association*, vol. 117, no. 538, pp. 591–601, 2022, doi: 10.1080/01621459.2021.2013241.
- [6] V. Gorsevski, E. Kasischke, J. Dempewolf, T. Loboda, and F. Grossmann, "Analysis of the Impacts of armed conflict on the Eastern Afromontane forest region on the South Sudan - Uganda border using multitemporal Landsat imagery," *Remote Sensing of Environment*, vol. 118, pp. 10–20, Mar. 2012, doi: 10.1016/j.rse.2011.10.023.
- [7] D. Armenteras, L. Schneider, and L. M. Dávalos, "Fires in protected areas reveal unforeseen costs of Colombian peace," *Nature Ecology and Evolution*, vol. 3, no. 1, pp. 20–23, Jan. 2019, doi: 10.1038/s41559-018-0727-8.
- [8] X. Li, F. Chen, and X. Chen, "Satellite-observed nighttime light variation as evidence for global armed conflicts," *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, vol. 6, no. 5, pp. 2302–2315, Oct. 2013, doi: 10.1109/JSTARS.2013.2241021.
- [9] L. Lu, Y. Zhu, and J. Gu, "Detecting the Impacts of Ongoing Russia-Ukraine Conflict on Crop Growth and Human Activity Using Multi-Modal Remote Sensing Time-Series Data," in *2024 12th International Conference on Agro-Geoinformatics (Agro-Geoinformatics)*, Novi Sad, Serbia, 2024, pp. 1–4, doi: 10.1109/Agro-Geoinformatics262780.2024.10660807.
- [10] H. Yin *et al.*, "Agricultural abandonment and re-cultivation during and after the Chechen Wars in the northern Caucasus," *Global Environmental Change*, vol. 55, pp. 149–159, Mar. 2019, doi: 10.1016/j.gloenvcha.2019.01.005.
- [11] E. S. López, S. J. C. Quintero, M. M. L. Rodríguez del Rey, and J. I. H. Fernández, "Bibliometry, an efficient to assess the postgraduate scientific activity," *Revista Científica de las Ciencias Médicas en Cienfuegos*, vol. 7, no. 4, pp. 291–294, 2009.
- [12] S. Aboudahr, S. Aslam, L. U. Hua, A. Misron, S. Raimé, and Y. B. Wah, "Mapping the global landscape of STEM education: a bibliometric analysis using Scopus database," *International Journal of Evaluation and Research in Education*, vol. 13, no. 6, pp. 4225–4236, Dec. 2024, doi: 10.11591/ijere.v13i6.28687.
- [13] M. J. Page *et al.*, "The PRISMA 2020 statement: An updated guideline for reporting systematic reviews," *BMJ Publishing Group*, vol. 372, Mar. 29, 2021, doi: 10.1136/bmj.n71.
- [14] N. J. van Eck and L. Waltman, "Software survey: VOSviewer, a computer program for bibliometric mapping," *Scientometrics*, vol. 84, no. 2, pp. 523–538, 2010, doi: 10.1007/s11192-009-0146-3.
- [15] M. Aria and C. Cuccurullo, "bibliometrix: An R-tool for comprehensive science mapping analysis," *Journal of Informetrics*, vol. 11, no. 4, pp. 959–975, Nov. 2017, doi: 10.1016/j.joi.2017.08.007.
- [16] J. Sadowski, "When data is capital: Datafication, accumulation, and extraction," *Big Data and Society*, vol. 6, no. 1, pp. 1–12, 2019, doi: 10.1177/2053951718820549.
- [17] J. R. Saura, B. R. Herraiz, and A. Reyes-Menendez, "Comparing a traditional approach for financial brand communication analysis with a big data analytics technique," *IEEE Access*, vol. 7, pp. 37100–37108, 2019, doi: 10.1109/ACCESS.2019.2905301.
- [18] K. Przyborowski, "The 2016 Colombian Peace Agreement and Colonial Continuities," *Latin American Perspectives*, vol. 52, no. 4 The Grenada Revolution: 40 Years After, pp. 190–207, Jul. 2025, doi: 10.1177/0094582X251337705.
- [19] C. Deshayes, "From Revolution to War in Sudan. Political Fragmentation, Competition for State Control and Widespread Conflict," *Politique africaine*, vol. 173, pp. 69–92, 2024, doi: 10.3917/polaf.173.0069.
- [20] R. B. García, "The Ukrainian Crisis: more than a conflict between Russia and Ukraine," *Anuario Espanol de derecho Internacional*, vol. 39, pp. 9–80, Apr. 2023, doi: 10.15581/010.39.9-80.

Remote sensing in armed conflict studies: a bibliometric analysis (Maritza Yulieth Tangarife–Marulanda)

- [21] P.-O. Gourinchas, "War clouds global economic outlook as inflation accelerates," International Monetary Fund, [Online]. Available: <https://www.imf.org/es/Blogs/Articles/2022/04/19/blog-weo-war-dims-global-economic-outlook-as-inflation-accelerates>. (Accessed: Sep. 29, 2025).
- [22] United Nations, "Peace, dignity and equality on a healthy planet," United Nation, [Online]. Available: <https://www.un.org/es/global-issues/peace-and-security>. (Accessed: Sep. 29, 2025).
- [23] R. Avtar *et al.*, "Remote sensing for international peace and security: Its role and implications," *Remote Sensing*, vol. 13, no. 3, p. 439, 2019, doi: 10.3390/rs13030439.
- [24] J. Al-doski, S. B. Mansor, and H. Z. M. Shafri, "War Impacts Studies Using Remote Sensing," *IOSR Journal of Applied Geology and Geophysics*, vol. 1, no. 2, pp. 11–15, 2013, doi: 10.9790/0990-0121115.
- [25] N. Levin, S. Ali, D. Crandall, and S. Kark, "World Heritage in danger: Big data and remote sensing can help protect sites in conflict zones," *Global Environmental Change*, vol. 55, pp. 97–104, March 2019, doi: 10.1016/j.gloenvcha.2019.02.001.
- [26] D. H. A. Al-Khudhairy, I. Caravaggi, and S. Giada, "Structural Damage Assessments from Ikonos Data Using Change Detection, Object-Oriented Segmentation, and Classification Techniques," *Photogrammetric Engineering & Remote Sensing*, vol. 71, no. 7, 2005, doi: 10.14358/PERS.71.7.825.
- [27] E. M. Ordway, "Political shifts and changing forests: Effects of armed conflict on forest conservation in Rwanda," *Global Ecology and Conservation*, vol. 3, pp. 448–460, Jan. 2015, doi: 10.1016/j.gecco.2015.01.013.
- [28] K. Stevens, L. Campbell, G. Urquhart, D. Kramer, and J. Qi, "Examining complexities of forest cover change during armed conflict on Nicaragua's Atlantic Coast," *Biodiversity and Conservation*, vol. 20, no. 12, pp. 2597–2613, Nov. 2011, doi: 10.1007/s10531-011-0093-1.
- [29] M. Hagenlocher, S. Lang, and D. Tiede, "Integrated assessment of the environmental impact of an IDP camp in Sudan based on very high resolution multi-temporal satellite imagery," *Remote Sensing of Environment*, vol. 126, pp. 27–38, Nov. 2012, doi: 10.1016/j.rse.2012.08.010.

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